Harmful Algal Blooms and Drinking Water

SF Bay Freshwater HABs Workshop

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May 9, 2016

Clear Lake, CA

Konocti County Water District transmission main, Oct 2014

Today's Talk

- Harmful Algal Blooms – a growing concern for drinking water
- US EPA's Health Advisories and Recommendations
  - *Cyanotoxin Management Plans*
- The Division of Drinking Water's role
- Assessment and Monitoring Considerations
- Treatment Considerations
- Public Messaging

Harmful Algal Blooms

A Drinking Water Concern

- Cyanobacterial blooms increasing – climate change and nutrient loading are driving factors
- Recreational/environmental exposure has been the primary focus of regulatory agencies (beach closures, dog deaths, impact on tribes, businesses)
- Drinking water community has traditionally focused on taste, odor, impact on treatment processes – with background awareness of toxicity issues
- August 2014: Toledo, OH episode focuses national attention on potential drinking water risks
- US EPA accelerates schedule for addressing HABs

Drinking Water Health Advisories

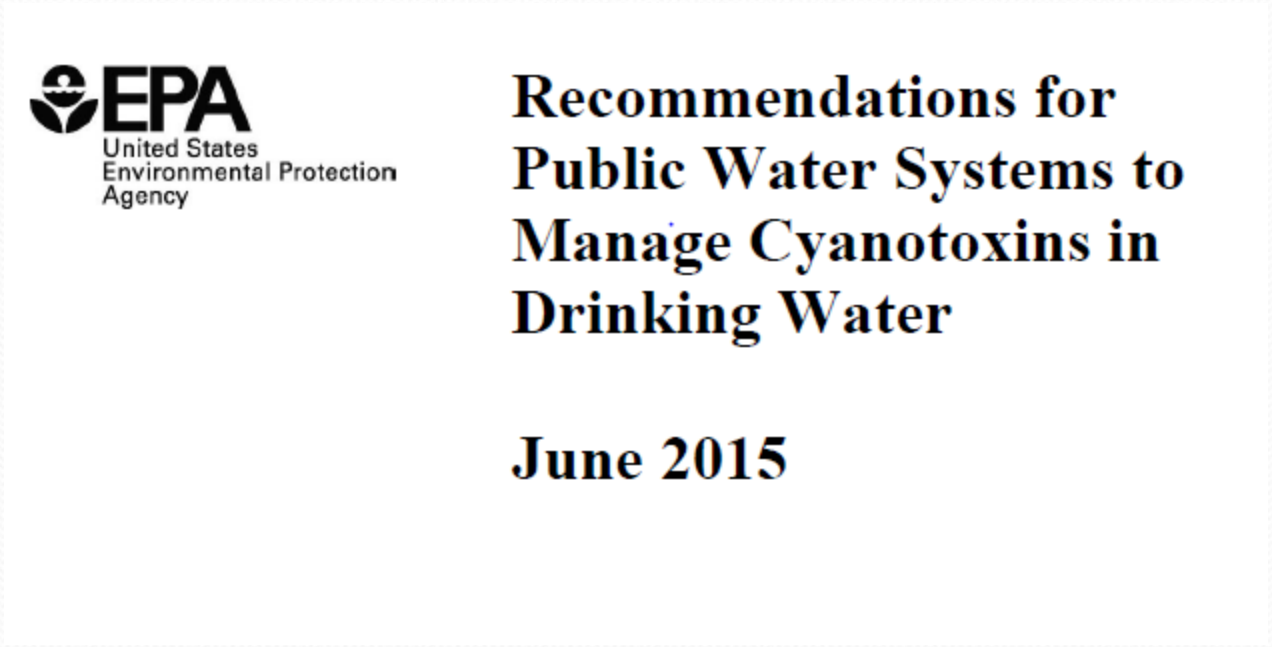
- Per US EPA: Heath advisories are non-regulatory concentrations at which adverse health effects are not anticipated to occur over specific exposure durations (e.g., one day, ten days, and lifetime).
- In June 2015, US EPA issued 10-day Drinking Water Health Advisories (HAs) for two cyanobacterial toxins: total microcystins and cylindrospermopsin.
- HAs are not legally enforceable, and are subject to change based on new information.

Drinking Water Health Advisories

- 10-day Health Advisory recommended concentrations for total microcystins are:
  - 0.3 µg/L for children younger than school age
  - 1.6 µg/L for all other age groups

- 10-day Health Advisory recommended concentrations for cylindrospermopsin are:
  - 0.7 µg/L for children younger than school age
  - 3.0 µg/L for all other age groups

Health Advisories are accompanied by…

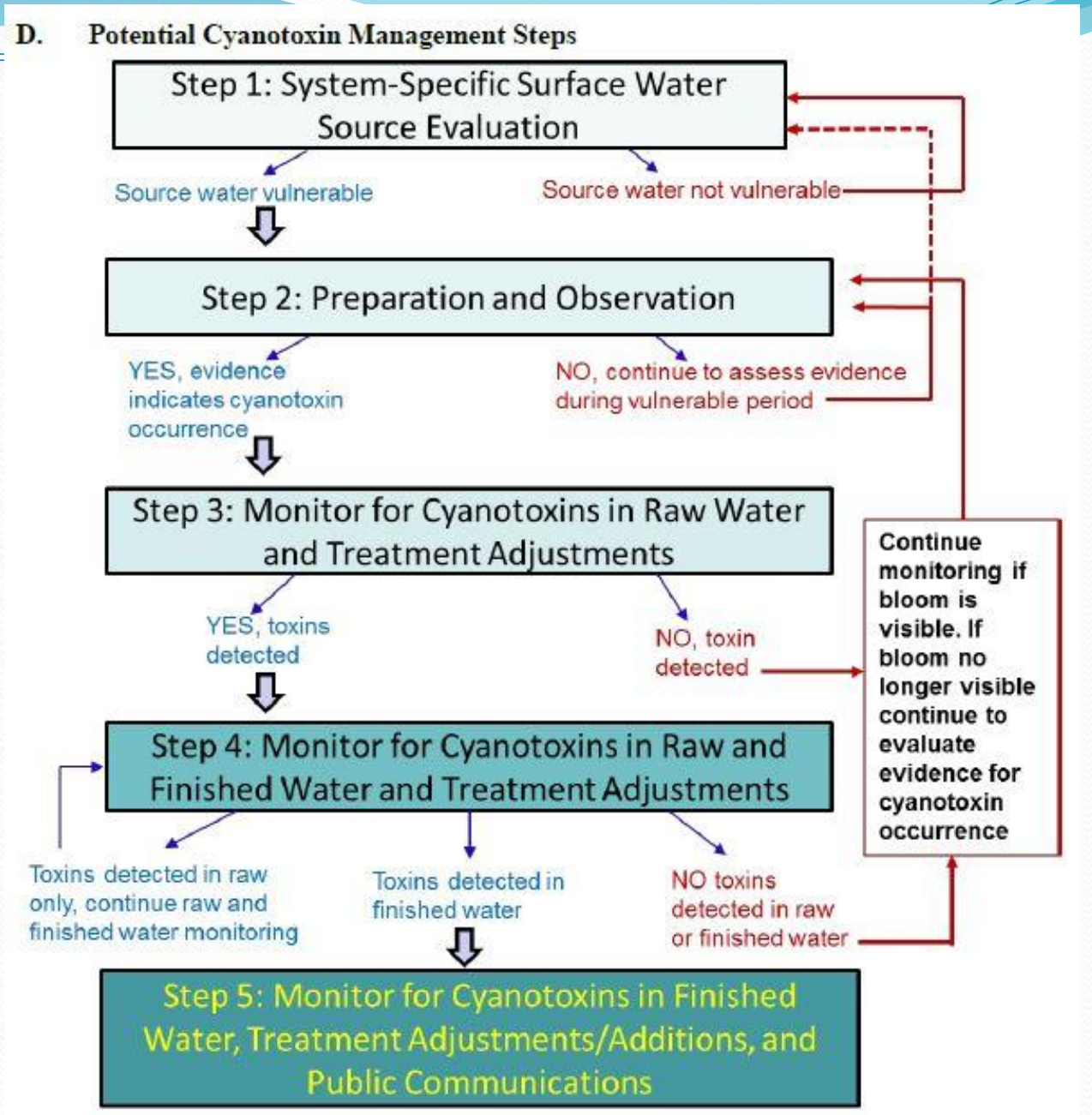


US EPA's *Recommendations*

- *Recommendations for Public Water Systems to Manage Cyanotoxins in Drinking Water*
- Issued June 2015, concurrent with release of HAs
- Discusses:
  - Health Advisories
  - Cyanotoxin Management Plan Development, addressing Monitoring, Treatment, and Communication
  - Models a "stepwise process" to help water systems reduce the risk of cyanotoxins in finished water

Cyanotoxin Management Steps

Figure taken from USEPA, *Recommendations for Public Water Systems to Manage Cyanotoxins in Drinking Water*, June 2015



Areas in California with Recurrent Toxic Algae Blooms

Klamath Basin

Clear Lake

San Francisco Bay area/Delta

Pinto Lake/Monterey Bay

Southern California
***Prymnesium* "Golden algae"**

And…

CA State Water Project!

Revision of Office of Environmental Health Hazard Assessment (OEHHA) Fact Sheet (2012)

SWAMP
Surface Water Ambient Monitoring Program

HAs and Division of Drinking Water

- DDW regulates Public Water Systems in CA (PWSs have 15 or more **service connections** or regularly serve at least 25 individuals daily at least 60 days out of the year).
- DDW does not have specific authority to require action from PWSs in response to the HAs.
- DDW Recommends that water systems refer to USEPA's Health Advisories and its *Recommendations for Public Water Systems to Manage Cyanotoxins in Drinking Water.*
- DDW offers to collaborate with water systems in developing Cyanotoxin Management Plans, monitoring plans, and communication/public messaging (if needed).

Assessment and Monitoring Considerations

- Need for:
  - Overall assessment of vulnerability, early warning of events
  - Identification of species
  - Chemical analysis of toxins
  - Speedy response to events!
- Obstacles
  - Lab availability, capacity, turnaround time
  - Limitations of ELISA method for microcystins
  - Cost! $$$$$$ (especially for smaller water systems)

Treatment Considerations

- USEPA and AWWA/WRF offer general treatment recommendations. (Further EPA guidance forthcoming!)
- Conventional treatment (coagulation, sedimentation, filtration) is effective in removing in-tact cells, but not extracellular toxins.
- Pre-oxidation can lyse cells, releasing toxins that will pass through conventional filters.
- Activated carbon can remove extracellular toxins.
  - Depends on TOC, type of carbon
- Some oxidants, such as ozone and free chlorine, can destroy some extracellular toxins.

Basic Treatment Guidelines

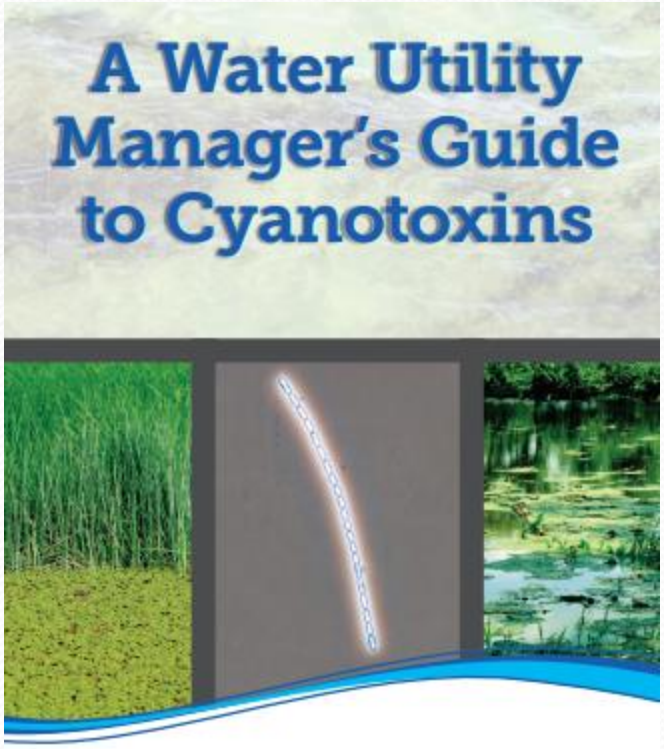


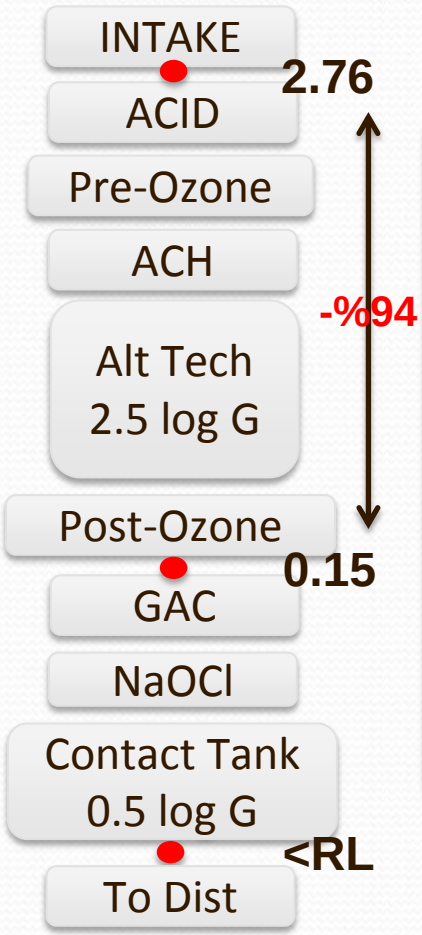
Table 5 Common cyanotoxin treatment practices and their relative effectiveness

Treatment Process	Relative Effectiveness
Intracellular Cyanotoxins Removal (intact cells)	
Conventional coagulation, sedimentation, filtration	Effective for the removal of intracellular/particulate toxins by removing intact cells. Generally more cost effective than chemical inactivation/degradation, removes a higher fraction of intracellular taste and odor compounds, and easier to monitor.
Flotation (e.g., dissolved air flotation)	Effective for removal of intracellular cyanotoxins because many toxin-forming cyanobacteria are buoyant.
Pretreatment oxidation (oxidant addition prior to rapid mix)	Overall, can either assist or make treatment more difficult, depending on the situation. Pre-oxidation processes may lyse (cause dissolution or destruction of) cells, causing the cyanotoxins contained within to release the toxins. Ozone may be an exception (see "Ozone" row) because it both lyses cells and oxidizes the cyanotoxins.
Membranes (microfiltration or ultrafiltration)	Effective at removing intracellular/particulate toxins. Typically membranes require pretreatment.
Extracellular Cyanotoxins Removal/Inactivation	
Chlorination	Effective for oxidizing extracellular cyanotoxins (other than anatoxin-a) when the pH is below 8
Chloramines	Not effective
Potassium permanganate	Effective for oxidizing microcystins and anatoxins. Not effective for cylindrospermopsin and saxitoxins.
Chlorine dioxide	Not effective with doses typically used in drinking water treatment
Ozone	Very effective for oxidizing extracellular microcystin, anatoxin-a, and cylindrospermopsin
Activated carbon (powdered activated carbon and granular activated carbon)	Most types generally effective for removal of microcystin, anatoxin-a, saxitoxins, and cylindrospermopsin. Because adsorption varies by carbon type and source water chemistry, each application is unique; activated carbons must be tested to determine effectiveness.
UV radiation	Degrades toxins when used at high doses, but not adequate to destroy cyanotoxins at doses used for disinfection.
Membranes (reverse osmosis [RO] or nanofiltration [NF])	RO effectively removes extracellular cyanotoxins. Typically, NF has a molecular weight cut off of 200 to 2,000 Daltons, which is larger than some cyanotoxins. Individual membranes must be piloted to verify toxin removal.

AWWA has also produced CT and PAC calculators.

Hypothetical Cyanotoxin Treatment Assessment @ City of Lakeport

Highest cyanotoxin concentration detected at intake



Tip #1: Use tools to answer questions
Fluorometer? SCM?

Raw:

Monitoring pH? Change in intake depths available? Possible to adapt to behave like a DAF? Recycled water introduced?

Acid addition: in operation? Target pH at what point

Pre-Ozone: Restrict dosage? Or crank it? Effective?

US Filter: evaluate time between flushes; consider using filter aids; consider adding intermediate sample point

Monitor number of backwashes; look for breakthrough

Nature of the charge going on to the filter bed

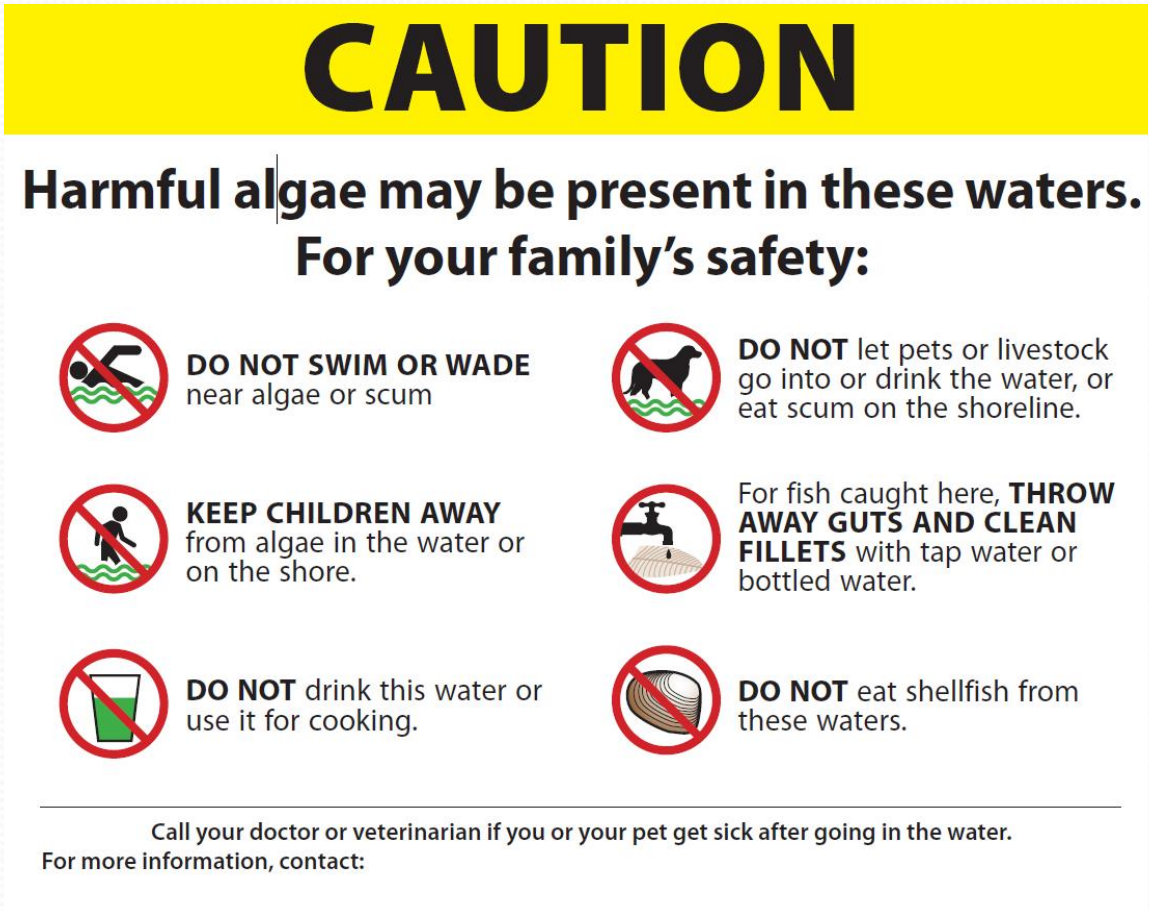
Post-Ozone: In operation? Effective?

GAC: Know that it is possible for cyanotoxin breakthrough to happen before traditional indicators for spent media are used

Know CT: 99.9% Giardia lamblia cyst reduction is required

Tip #2: Know what stage the bloom is in

Public Messaging



CAUTION

Harmful algae may be present in these waters.
For your family's safety:

DO NOT SWIM OR WADE near algae or scum

DO NOT let pets or livestock go into or drink the water, or eat scum on the shoreline.

KEEP CHILDREN AWAY from algae in the water or on the shore.

For fish caught here, **THROW AWAY GUTS AND CLEAN FILLETS** with tap water or bottled water.

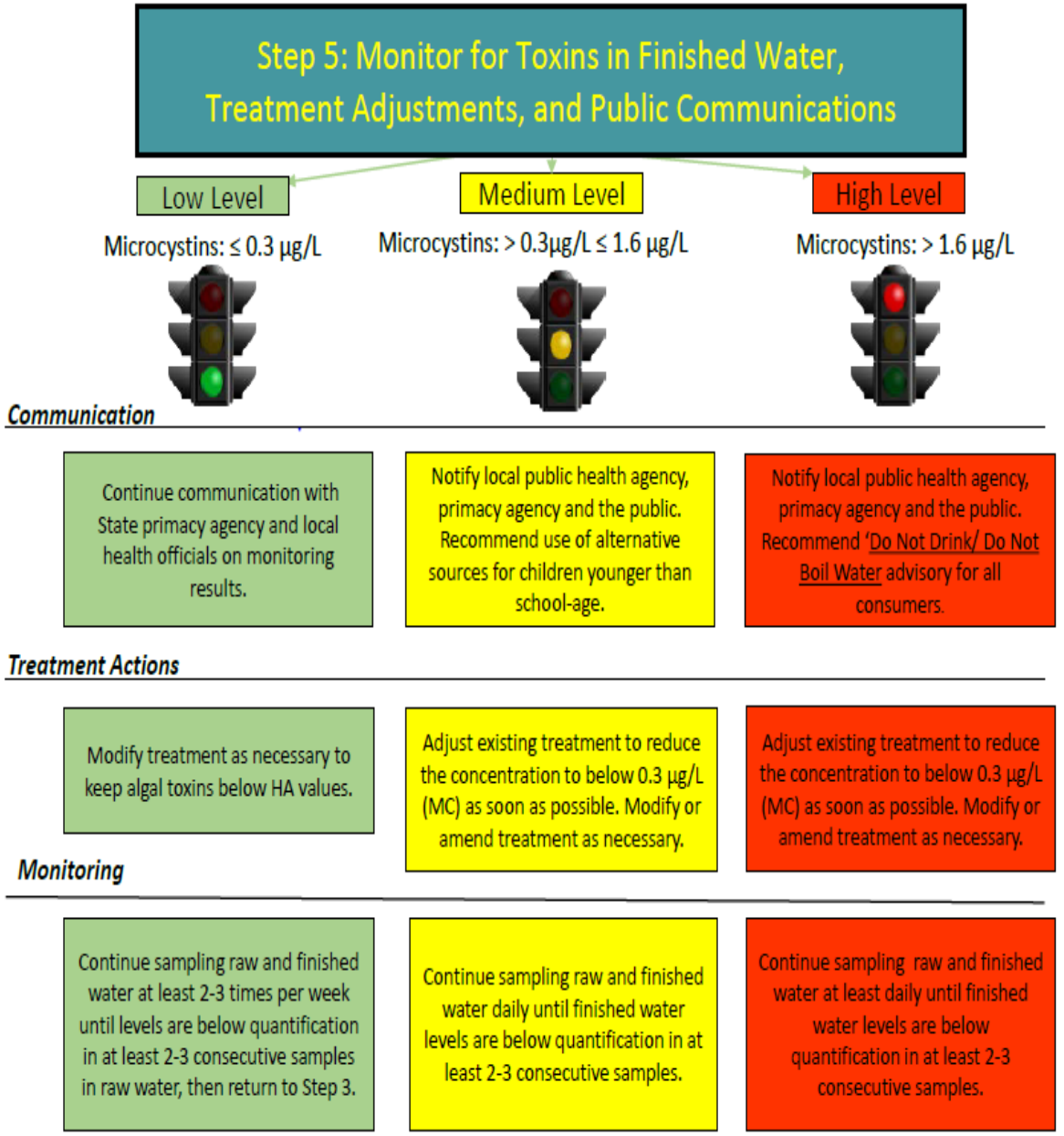
DO NOT drink this water or use it for cooking.

DO NOT eat shellfish from these waters.

Call your doctor or veterinarian if you or your pet get sick after going in the water.
For more information, contact:

HAs and Public Communication

Figure taken from USEPA, *Recommendations for Public Water Systems to Manage Cyanotoxins in Drinking Water,* June 2015



Public Messaging

- Not regulated – will water systems choose to notify if Health Advisory levels exceeded in finished water?
- Is a two-tiered HA realistic?
- How to communicate that cyanotoxins are a threat, but there is no MCL, no required response from water system?
- DDW has enlisted help from CDPH/EHIB in developing language for public notice template.
- IMPORTANT: involve local health officer and director of environmental health.

Sample Public Notice

WARNING: Do Not Drink Your Tap Water

We found [*insert specific cyanotoxin*], **a very harmful toxin**, in tap water in your area.

- **This toxin may be dangerous to everyone.** Use a different source of water for drinking and cooking.
- **Boiling or filtering your tap water will not get rid of the problem.** Do not use your tap water for drinking or cooking even if it has been boiled or filtered.
- Your tap water is safe for bathing, washing hands, shaving, washing dishes, house cleaning, laundry and watering the yard/plants.

[*insert specific cyanotoxin*] is made during a harmful algal bloom (HAB) by a kind of algae that formed naturally at the site where your water comes from. We found [*insert specific cyanotoxin*] in your tap water by testing a water sample on [*insert date*] and again on [*insert date*]. We are making changes to the way we treat your water to lower the amount of [*insert specific cyanotoxin*] as quickly as possible.

DDW District Offices

If you are aware of a Harmful Algal Bloom that might affect drinking water, contact the local DDW office!

Additional Information

- Division of Drinking Water website:

http://www.waterboards.ca.gov/drinking_water/programs/index.shtml
http://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/publicwatersystems.shtml

- Contact your local DDW field office

http://www.swrcb.ca.gov/drinking_water/programs/documents/ddwem/DDWdistrictofficesmap.pdf

- DDW Cyanotoxin Web Page:

http://www.waterboards.ca.gov/drinking_water/programs/habs/

- USEPA Cyanotoxin Web Page:

http://www.epa.gov/nutrient-policy-data/cyanobacteriacyanotoxins

- AWWA/WRF Guidance for Water Utilities:

http://www.waterrf.org/PublicReportLibrary/4548a.pdf

Contact Information

Division of Drinking Water Richmond Office

(510) 620-3474

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